Decreasing Variability in Health Care

HST950

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Variability in Health Care

- Decision support systems
  - Integration of guidelines into practice
    - Decrease variability, homogenize
  - Knowledge discovery in biomedical data
    - Increase variability, customize
- Support for clinical trials
Guidelines and clinical protocols

- What are they?
- Why computerize?
- Knowledge representation
- Application in breast cancer protocol eligibility with uncertain information
Decreasing practice variation

- Studies demonstrate huge variability in practices
What are clinical guidelines?

- Institute of Medicine definition
  - systemically developed statements to assist practitioner and patient decisions about appropriate healthcare for specific clinical circumstances

- A recommended strategy for management of a medical problem in order to
  - Reduce inappropriate use of resources $$$$$$$
  - Reduce practice variation
  - Improve outcomes
Conventional publication

- Guidelines can be developed and published by
  - A medical institution, to be used locally
  - National and international organizations, used by many medical institutions

- Conventional publication
  - In journals and textbooks
  - Booklets or guideline summaries
  - Compilations of guidelines for reference
Types of guidelines

- Risk assessment
- Chronic disease management
  - Diabetes, asthma, hypertension
- Screening
- Diagnosis and workup
- Protocol-based care (clinical trials)
Clinical Trial Protocols

- Goal is to intervene in a random part of the eligible patient and leave the other part with current standard of care
- Carefully selected population, with few comorbidities (other diseases)
- Homogeneous care in each arm to investigate statistical significance of differences

Select patients
Randomize into
  - intervention arm
  - control arm
Compare outcomes
Where do the recommendations come from?

- Panel of experts (most common)
  - Hard to get experts to agree on anything
- Decision analysis models (least common)
  - Difficult to obtain probabilities and utilities
- Observational studies
  - Small numbers may lead to wrong recommendations
- Clinical trials
  - Controlled populations, strict eligibility criteria

A major problem is to match the patient in front of you with carefully selected patient population used in the trials.
Ways of helping implement guidelines/clinical trials

- Help authors to create guidelines that make sense (verify the "logic")
- Eligibility determination for a variety of competing guidelines/protocols
- Assistance in implementing the prescribed actions
Eligibility determination

- There are hundreds of guidelines and clinical trials out there.

- Automated eligibility could warn providers of guidelines/protocols that match the patient.

- MAJOR problem: uncertainty in patient status (tests to be done, info not available).
Increase versus decrease variability

- Recommendations are based on “average” or “mode” patient

- “Mode” patient may not exist

- If more info is available, why not use it?
Example

- Consent forms for interventional cardiology procedures:
  - Acknowledgement that risk of death in hospital is about 2%
  - Who is at 2% risk?
Why people want to computerize guidelines

- Provide automatic decision support
  - Applied to individual patients
  - During the clinical encounter

- Ambiguities in guidelines may be reduced
  - Software tools and guideline models can promote specifying logic precisely

- Can integrate guidelines into workflow
  - Patient-specific guideline knowledge available at point of care

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Computer-interpretable guidelines

- Interactive guidelines
  - Enter patient parameters to traverse guideline

- Guidelines embedded in EPR Systems
  - Automated reminders/alerts
  - Decision support and task management
... Why people want to computerize guidelines

- Can be used for quality assurance
  - Guideline defines gold-standard of care
  - Perform retrospective analysis to test if patients were treated appropriately

- Allows for interactive visualization of guideline logic
  - e.g., allows one to focus on relevant sections of flowchart

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Why share guidelines?

- Provide consistency in guideline interpretation
- Reduce cost of guideline development
- Minimize misinterpretations and errors through the process of public review
Challenges in sharing guidelines

- Local adaptation of guidelines
  - Must allow care sites flexibility in modifying guidelines for
    - Availability of resources and expertise
  - Local workflow issues
  - Practice preferences
  - Differences in patient population
Patient and Provider Preferences

- Who cares?
- Who elicits preferences for a particular patient?
- How does this get taken into account?
Patient and Clinician Vocabulary: How Different Are They?
...Challenges in sharing guidelines

- Integration with information systems
  - Match patient data in EPR to terms in guideline
  - Match recommendations in guideline to actions in order entry system
Guideline models

- Guideline models make explicit
  - Knowledge concepts contained in a guideline
  - Structure of the concepts and relationships among them
  - Scope of the model
    - Types of guidelines, e.g. alerts vs. multi-encounter guidelines
    - Level of detail, e.g. structured or text specification
Models for guidelines and rules

- Individual decision rules (single step)
  - Arden Syntax

- Multi-step guidelines, modeled as sets of guideline tasks that are connected in a graph
  - nested
Arden Medical Logic Modules

- Format for representation and sharing of single medical decision

- Each medical decision (rule) is called a medical logic module (MLM)

- Suitable for alerts and reminders

- A guideline may be represented by a chained set of MLMs
...Arden MLM

☐ Simplified example
  ▪ data:
    ▪ potassium_storage := event {‘1730’};
    ▪ potassium := read last { ‘32471’};
  ▪ evoke: potassium_storage (to EPR)
  ▪ logic: potassium > 5 mmol/L
  ▪ action: write “Potassium is significantly elevated”;
…Arden Syntax

- Standard published by ANSI
- Part of HL7 activity
- Supported by many commercially-available hospital information systems
...Models for multi-step guidelines

- Multi-step guidelines, modeled as hierarchical sets of nested guideline tasks
  - EON
  - PRODIGY
  - PROforma
  - Asbru
  - GLIF

This is an incomplete list!
EON

- Developed by Tu and Musen (Stanford)
- Extensible collection of models where guideline developers select modeling solutions from a toolkit
- Concept model, patient information model, guideline model
  - e.g., multiple abstraction methods
- Temporal query based on formal temporal model
- Temporal abstraction use specifications of abstractions in knowledge base
PRODIGY

- Developed by Ian Purves, Peter Johnson, and colleagues, at the U of Newcastle, UK

- Simple and understandable model
  - Few modeling primitives
  - Complexity management techniques
  - Eases the encoding process

- Sufficiently expressive to represent chronic disease management GLs
Proforma

- Developed by John Fox et al., (ICRF, UK)

- Emphasis on soundness, safety, and verifiability
  - PROforma is a formal specification language, based on a logic language

- Guidelines are constraint satisfaction graphs
  - Nodes represent guideline tasks
Asbru

- Developed by Shahar, Miksch and colleagues
- Emphasis on guideline intentions, not only action prescriptions
  - e.g., maintain a certain blood pressure
- Expressive language for representing time-oriented actions, conditions, and intentions in a uniform fashion
- Guidelines are modeled as plans that can be hierarchically decomposed into (sub)plans or actions
GuideLine Interchange Format: Version 3

- Emphasis on sharing guidelines across different institutions and software applications
  - A consensus-based multi-institutional process (InterMed: a collaboration of Stanford, Harvard, Columbia)
  - An open process – the product is not proprietary
  - Supports the use of vocabularies and medical knowledge bases
Object-oriented representation model for guidelines

Guideline
  name
  author
Guideline Step
  Has parts
  Has specializations
Action Step
Decision Step
Branch Step
Synchronization Step
Patient State Step
...
... GLIF3

- **Action steps**: recommendations for clinical actions to be performed
  - e.g., Prescribe aspirin

- **Decision steps**: decision criteria for conditional flowchart traversal
  - e.g., if patient has pain then ...

- **Action and decision steps** can be nested

- **Branch and synchronization steps** allow concurrency
... GLIF3

- Patient-state step
  - characterize patient’s clinical state
  - serve as entry points into the guideline

- Steps refer to patient data items (age, cough)

- Expression language: derived from Arden Syntax logic grammar

- Medical domain ontology
GLIF3

- Medical ontology
  - Concept model
    - Concepts defined by id from controlled vocabulary
    - Concept relationships (e.g., contradiction, is-a)
  - Patient information model
    - Default model is based on HL7 RIM
    - User-defined concepts and data model classes
Workshop: Towards a Sharable Guideline Representation

- Hosted by InterMed in March 2000 in Boston
- 80 attendees from 8 countries
- Representation from
  - Government
  - Professional specialty organizations
  - Insurers
  - Health care provider organizations
  - Academic medical informatics
  - Industry
Purpose of the meeting

- To recognize the need for a standard
- To identify the functional requirements for sharing guidelines
- To establish a process for the development of a robust representation model
- To establish a process to foster sharing
Life cycle of a computer-interpretable guideline

**USE**
- Use and maintenance
- Performance analysis

**DEVELOPMENT**
- Authoring
- Encoding
- Validation

**IMPLEMENTATION**
- Dissemination
- Local adaptation and implementation
- Testing

Life cycle of a computer-interpretable guideline
Take home message

- It is not all about the technical difficulty...
- It is about whether people believe in guidelines
- It is about whether how a guideline fits a particular case
- It is about whether it makes a difference for this particular case